CLAIMS

What is claimed is:

1. A method for depositing copper overlying a work piece, the method comprising the steps of:

depositing overlying the work piece a barrier layer having a surface;

subjecting said surface of said barrier layer to a surface treatment adapted to facilitate deposition of copper on said barrier layer; and

electrochemically depositing copper overlying said barrier layer.

2. The method of claim 1, wherein the step of electrochemically depositing comprises at least one of depositing by electroplating and depositing by electrochemical mechanical deposition.

3. The method of claim 1, wherein the step of depositing overlying a work piece a barrier layer comprises depositing overlying the work piece a layer of material selected from the group comprising ruthenium, cobalt, molybdenum, tungsten, rhodium, palladium, osmium, rhenium, iridium, and platinum.

4. The method of claim 1, wherein the step of subjecting said surface of said barrier layer to a surface treatment comprises the step of forming a protective layer that overlies said surface and that inhibits oxidation of said surface.

5. The method of claim 4, wherein the step of forming a protective layer comprises the step of exposing said surface of said barrier layer to a gas selected from the group comprising silane, diborane, sulfur-containing gases, nitrogen-containing gases and phosphorous-containing gases.

6. The method of claim 4, wherein the step of forming a protective layer comprises forming a protective layer having a thickness no greater than about 20 angstroms.

7. The method of claim 4, further comprising the step of removing said protective layer prior to the step of electrochemically depositing copper.

8. The method of claim 7, wherein the step of removing said protective layer comprises the step of removing said protective layer using an etchant.

9. The method of claim 8, wherein the step of removing said protective layer using an etchant comprises the step of exposing said protective layer to a solution formed of at least one selected from the group comprising sulfuric acid, nitric acid, and a combination of sulfuric acid and hydrogen peroxide.

10. The method of claim 7, wherein the step of removing said protective layer comprises the step of removing said protective layer using a copper plating solution.

11. The method of claim 4, wherein the step of forming a protective layer comprises the step of forming a copper film having a thickness of less than approximately 20 angstroms overlying said barrier layer.

12. The method of claim 1, wherein the step of depositing a barrier layer comprises the step of forming a barrier layer by a process selected from the group comprising CVD, ALD, PVD, and electroless deposition.

13. The method of claim 4, wherein the step of depositing a barrier layer and the step of forming a protective layer are performed in the same processing apparatus.

14. The method of claim 13, wherein the step of depositing a barrier layer and the step of forming a protective layer are performed in the same processing chamber of a processing apparatus.

15. The method of claim 1, wherein the step of subjecting said surface of said barrier layer to a surface treatment comprises the step of exposing said surface of said barrier layer to an acidic solution.

16. The method of claim 15, further comprising the step of exposing said surface of said barrier layer to an alkaline solution after the step of exposing said surface of said barrier layer to an acidic solution and before the step of electrochemically depositing copper overlying said barrier layer.

17. The method of claim 15, wherein the step of exposing said surface of said barrier layer to an acidic solution comprises the step of exposing said surface of said barrier layer to a solution formed from at least one acid selected from the group comprising sulfuric acid, nitric acid, hydrochloric acid, and aquaregia.

18. The method of claim 15, wherein the step of exposing said surface of said barrier layer to an acidic solution comprises the step of exposing said surface of said barrier layer to an acidic solution having an acidic concentration of about ten percent (10%) to about sixty percent (60%) by weight.

19. The method of claim 1, wherein the step of subjecting said surface of said barrier layer to a surface treatment comprises exposing said surface of said barrier layer to an alkaline solution.

20. The method of claim 19, wherein the step of subjecting said surface of said barrier layer to an alkaline solution comprises exposing said surface of said barrier layer to an alkaline solution formed from at least one selected from the group comprising sodium hypochlorite, potassium hypochlorite, sodium chlorite, potassium chlorate, sodium perchlorate, potassium perchlorate, and potassium permanganate.

21. The method of claim 19, further comprising the step of exposing said surface of said barrier layer to an acidic solution after the step of exposing said surface of said barrier layer to an alkaline solution and before the step of electrochemically depositing copper overlying said barrier layer.

22. The method of claim 1, wherein the step of subjecting said surface of said barrier layer to a surface treatment comprises the step of applying to said surface of said barrier layer an anodic current.

23. The method of claim 22, wherein the step of applying to said surface of said barrier layer an anodic current comprises the step of applying to said surface of said barrier layer an anodic current having a magnitude in the range of about 1 to about 50 mA/cm^2.

24. The method of claim 22, wherein the step of applying to said surface of said barrier layer an anodic current comprises the step of applying to said surface of said barrier layer an anodic current for a period in the range of about 0.5 second to about 10 seconds.

25. The method of claim 1, wherein the step of subjecting said surface of said barrier layer to a surface treatment comprises applying to said surface of said barrier layer a an initial cathodic current pulse.

26. The method of claim 25, wherein the step of applying to said surface of said barrier layer an initial cathodic current pulse comprises the step of applying to said surface of said barrier layer an initial cathodic current pulse having a magnitude in the range of about 25 to about 200 mA/cm^2.

27. The method of claim 25, wherein the step of applying to said surface of said barrier layer an initial cathodic current pulse comprises the step of applying to said surface of said barrier layer an initial cathodic current pulse for a period in the range of about 0.5 second to about 10 seconds.

28. The method of claim 25, wherein the step of subjecting said surface of said barrier layer to a surface treatment comprises applying to said surface of said barrier layer an anodic current before the step of applying to said surface of said barrier layer an initial cathodic current pulse.

29. A method for electrochemically depositing a copper layer onto a ruthenium layer of a work piece, the method comprising the steps of:

depositing on the work piece a ruthenium layer having a surface;

forming a protective layer that overlies said surface; and

electrochemically depositing a layer of copper overlying said ruthenium layer.

30. The method of claim 29, wherein the step of forming a protective layer comprises the step of exposing said surface of said ruthenium layer to a material selected from the group comprising silane, diborane, sulfur-containing gases, nitrogen-containing gases and phosphorous-containing gases.

31. The method of claim 29, wherein the step of forming a protective layer comprises forming a protective layer having a thickness no greater than about 20 angstroms.

32. The method of claim 29, further comprising the step of removing said protective layer prior to the step of electrochemically depositing a layer of copper.

33. The method of claim 32, wherein the step of removing said protective layer comprises the step of removing said protective layer using an etchant.

34. The method of claim 33, wherein the step of removing said protective layer using an etchant comprises the step of exposing said protective layer to a solution formed of at least one selected from the group comprising sulfuric acid, nitric acid, and a combination of sulfuric acid and hydrogen peroxide.

35. The method of claim 32, wherein the step of removing said protective layer comprises the step of removing said protective layer using a copper plating solution.

36. The method of claim 29, wherein the step of forming a protective layer comprise the step of forming a copper film having a thickness of less than approximately 20 angstroms overlying said barrier layer.

37. The method of claim 29, wherein the step of depositing a ruthenium layer comprises the step of forming a ruthenium layer by a process selected from the group comprising CVD, ALD, PVD, and electroless deposition.

38. The method of claim 37, wherein the step of depositing a ruthenium layer and the step of forming a protective layer are performed in the same processing apparatus.

39. The method of claim 38, wherein the step of depositing a ruthenium layer and the step of forming a protective layer are performed in the same processing chamber of a processing apparatus.

40. A method for electrochemically depositing a copper layer onto a ruthenium layer of a work piece, the method comprising the steps of:

depositing on the work piece a ruthenium layer having a surface;

subjecting said surface of said ruthenium layer to an etchant; and

electrochemically depositing a layer of copper overlying said ruthenium layer.

41. The method of claim 40, wherein the step of subjecting said surface of said ruthenium layer to an etchant comprises the step of exposing said surface of said ruthenium layer to an acidic solution.

42. The method of claim 41, further comprising the step of exposing said surface of said ruthenium layer to an alkaline solution after the step of exposing said surface of said ruthenium layer to an acidic solution and before the step of electrochemically depositing a layer of copper overlying said ruthenium layer.

43. The method of claim 41, wherein the step of exposing said surface of said ruthenium layer to an acidic solution comprises exposing said surface of said ruthenium layer to a solution formed from at least one acid selected from the group comprising sulfuric acid, nitric acid, hydrochloric acid, and aquaregia.

44. The method of claim 41, wherein the step of exposing said surface of said ruthenium layer to an acidic solution comprises exposing said surface of said ruthenium layer to an acidic solution having an acidic concentration of about ten percent (10%) to about sixty percent (60%).

45. The method of claim 40, wherein the step of subjecting said surface of said ruthenium layer to an etchant comprises the step of exposing said surface of said ruthenium layer to an alkaline solution.

46. The method of claim 45, wherein the step of exposing said surface of said ruthenium layer to an alkaline solution comprises exposing said surface of said ruthenium layer to an alkaline solution formed from at least one selected from the group comprising sodium hypochlorite, potassium hypochlorite, sodium chlorite, potassium chlorate, sodium perchlorate, potassium perchlorate, and potassium permanganate.

47. The method of claim 45, further comprising the step of exposing said surface of said ruthenium layer to an acidic solution after the step of exposing said surface of said ruthenium layer to an alkaline solution and before the step of electrochemically depositing a layer of copper overlying said ruthenium layer.

48. A method for electrochemically depositing a copper layer onto a ruthenium layer of a work piece, the method comprising the steps of:

depositing on the work piece a ruthenium layer having a surface;

applying to said surface of said ruthenium layer an anodic current; and

electrochemically depositing a layer of copper overlying said ruthenium layer using a cathodic current.

49. The method of claim 48, wherein the step of applying to said surface of said ruthenium layer an anodic current comprises the step of applying to said surface of said ruthenium layer an anodic current having a magnitude in the range of about 1 to about 50 mA/cm^2.

50. The method of claim 48, wherein the step of applying to said surface of said ruthenium layer an anodic current comprises the step of applying to said surface of said ruthenium layer an anodic current for a period in the range of about 0.5 second to about 10 seconds.

51. A method for electrochemically depositing a copper layer onto a ruthenium layer of a work piece, the method comprising the steps of:

depositing on the work piece a ruthenium layer having a surface;

applying to said surface of said ruthenium layer an initial cathodic current pulse that has an initial cathodic current pulse magnitude; and

electrochemically depositing a layer of copper overlying said ruthenium layer using a cathodic current that has an initial magnitude that is less than said initial cathodic current pulse magnitude.

52. The method of claim 51, wherein the step of applying to said surface of said ruthenium layer an initial cathodic current pulse that has an initial cathodic current pulse magnitude comprises the step of applying to said surface of said ruthenium layer an initial cathodic current pulse that has an initial cathodic current pulse magnitude in the range of about 25 to about 200 mA/cm^2.

53. The method of claim 51, wherein the step of applying to said surface of said ruthenium layer an initial cathodic current pulse that has an initial cathodic current pulse magnitude comprises the step of applying to said surface of said ruthenium layer an initial cathodic current pulse for a period in the range of about 0.5 to about 10 seconds.

54. The method of claim 51, further comprising the step of applying to said surface of said ruthenium layer an anodic current before the step of applying to said surface of said ruthenium layer an initial cathodic current pulse.